

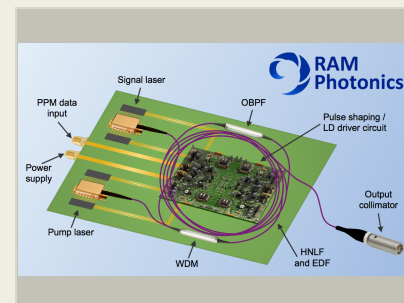
Low-Power-Consumption Integrated PPM Laser Transmitter, Phase I

Completed Technology Project (2016 - 2016)



Project Introduction

Conventional PPM laser transmitters, a CW laser followed by a modulator, are inherently inefficient since the data must be carved from the laser's steady output. 95% of the optical power is discarded in a standard telecom RZ format, with another $\geq 8\times$ efficiency reduction using a PPM scheme. An alternative is to form the pulse train with a mode-locked laser. However, since the resultant MLL pulse train is periodic, it must produce pulses in every symbol slot, not just once per symbol. This means that for a 32-ary PPM scheme, the MLL optical efficiency is reduced by a factor of at least 32 by discarding the un-needed pulses. In both cases, the electro-optic modulator itself induces an additional 60% optical loss, and requires nearly 0.5W of power to drive. An alternative is to use a low-repetition-rate MLL in combination with a switch fabric to delay each output pulse into the correct PPM slot. However, the use of photonic integrated circuits (e.g., silicon) is prohibitive due to the high intrinsic loss. A 100-MHz PPM data rate scheme requires $\sim 5\text{ns}$ pulse delay. This represents 43-cm propagation in silicon, inducing a power loss $\geq 10\text{ dB}$. Adding the loss due to spiraled delay lines, switch junctions, and coupling on/off chip, the aggregate loss of the switch fabric is 18 to 24 dB, representing a significant efficiency loss. RAM Photonics proposes the development of a qualitatively novel approach to high-efficiency, low-bit-rate laser transmitters compatible with space-borne missions. Specifically, we propose to develop a laser transmitter that attains highly efficiency optical data generation by (1) generating only one optical pulse per symbol at arbitrary temporal location, (2) eliminating all electro-optic modulators, and (3) exploiting a nearly lossless fiber architecture. The new transmitter device has low dissipation ($< 0.5\text{ W}$ total) and low SWaP footprint, and can operate at arbitrary data rates and generate any symbol formats.



Low-Power-Consumption
Integrated PPM Laser
Transmitter, Phase I

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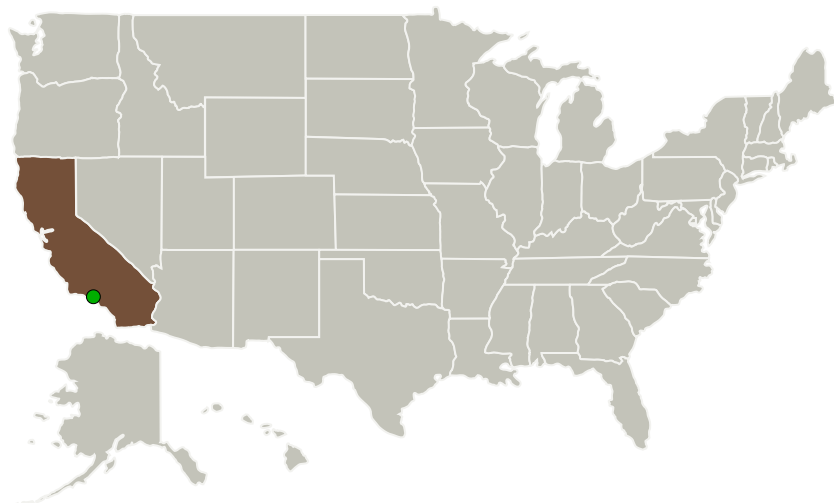
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
RAM Photonics	Lead Organization	Industry	San Diego, California
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations

California

Project Transitions

**June 2016:** Project Start**December 2016:** Closed out**Closeout Documentation:**

- Final Summary Chart(<https://techport.nasa.gov/file/139569>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

RAM Photonics

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

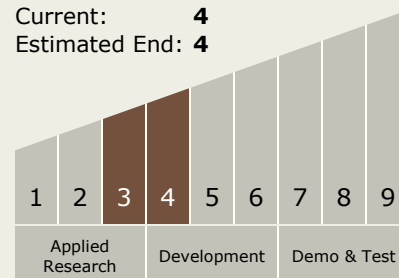
Carlos Torrez

Principal Investigator:

John Marciante

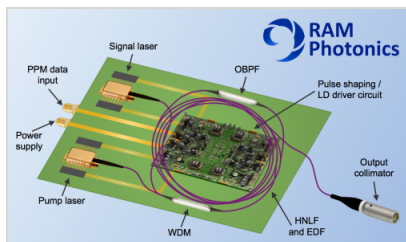
Technology Maturity (TRL)

Start: **3**
 Current: **4**
 Estimated End: **4**



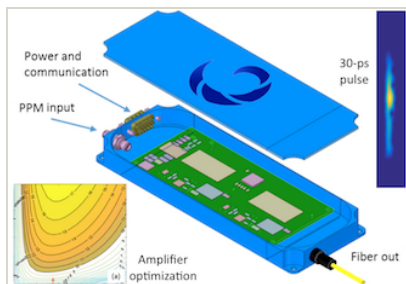


Images



Briefing Chart Image

Low-Power-Consumption
Integrated PPM Laser Transmitter,
Phase I
(<https://techport.nasa.gov/image/131404>)



Final Summary Chart Image

Low-Power-Consumption
Integrated PPM Laser Transmitter,
Phase I Project Image
(<https://techport.nasa.gov/image/128747>)

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
 - └ TX05.1 Optical Communications
 - └ TX05.1.3 Lasers

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System